Focus on Middle School: Discourse and Productive Struggle

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Today’s Action-Packed Agenda

• Focusing on Two Effective Mathematics Teaching Practices
• Discourse: Counting Cubes and The Case of Peter Dubno
• **Productive Struggle**: Joe’s on the Beach Ice Cream
• Supporting Discourse and Productive Struggle in Virtual and Hybrid Teaching
Taking Action Series

• Identify research-based high-leverage mathematics teaching practices

• Explore those practices in the context of the everyday work of teaching

• Provide opportunities to work on these practices in your own classroom

Effective Mathematics Teaching Practices

A research-based consensus on what constitutes good teaching
Changing Instruction Means Changing Beliefs

Many parents and educators believe that students should be taught as they were taught, through memorizing facts, formulas, and procedures and then practicing skills over and over again (e.g., Sam and Ernest 2000). This view perpetuates the traditional lesson paradigm that features review, demonstration, and practice and is still pervasive in many classrooms (Banilower et al. 2006; Weiss and Pasley 2004).

Teachers, as well as parents, are often not convinced that straying from these established beliefs and practices will be more effective for student learning (Barkatsas and Malone 2005; Wilken 2008).
Effective Mathematics Teaching Practices

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.
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Discourse:
Counting Cubes &
The Case of Peter Dubno
Facilitate Meaningful Mathematical Discourse

Mathematical Discourse should:

• Build on and honor students’ thinking;

• Provide students with the opportunity to share ideas, clarify understandings, and develop convincing arguments; and

• Advance the mathematical learning of the whole class.

Discussions that focus on cognitively challenging mathematical tasks...are a primary mechanism for promoting conceptual understanding of mathematics (Hatano & Inagaki 1991; Michaels, O’Connor & Resnick 2008).

(Smith, Hughes, Engle and Stein 2009, p. 549)
Counting Cubes

What important mathematical ideas would you expect to hear students talking about with this task?

1. Describe a pattern you see in the cube buildings.
2. Use your pattern to write an expression for the number of cubes in the $n^{th}$ building.
3. Use your expression to find the number of cubes in the $5^{th}$ building. Check your results by constructing the $5^{th}$ building and counting the cubes.
4. Look for a different pattern in the buildings. Describe the pattern and use it to write a different expression for the number of cubes in the $n^{th}$ building.
The Case of Peter Dubno: Goals

Students will understand that:

• An equation can be written that describes the relationship between 2 quantities (i.e., the number of cubes and the building number);

• Different but equivalent equations can be written that represent the same situation;

• Connections can be made between pictorial and symbolic representations; and

• Variables must be clearly defined.
The Case of Peter Dubno: Context

Earlier in the class:

• Students solved the Counting Cubes Task.
• The tables and equations students produced in response to the task were posted in the classroom.

The Video Clip begins as pairs of students explain the thought processes they used to connect the volume or number of cubes in each picture with their equation. The students then point out differences and similarities in the equations generated.
The Case of Peter Dubno: Video Lens

As you watch the video, consider the following:

• What does the discourse reveal about students’ understandings of the connections between the pictorial and algebraic representations?

• To what extent does the discourse facilitate students explanations, or clarifications of their thinking?

• To what extent does the discourse make mathematics more visible and accessible for student examination and discussion?
The Case of Peter Dubno

What do you think Mr. Dubno did before and during the lesson to prepare to facilitate meaningful mathematics discourse in this clip?
Facilitate Meaningful Mathematical Discourse

5 Practices for Orchestrating Productive Discussions

• Anticipating
• Monitoring
• Selecting
• Sequencing
• Connecting

Smith & Stein (2018)
Smith, Steele, & Sherin (2020)

Teacher Discourse Moves: Mathematics Discourse in Secondary Classrooms

• Waiting
• Inviting student participation
• Revoicing
• Asking students to revoice
• Probing a student’s thinking
• Creating opportunities to engage with another’s reasoning

Herbel-Eisenmann, Cirillo, Steele, Otten, & Johnson (2017)
Meaningful Mathematics Discourse in Virtual and Hybrid Teaching

• Have small groups solve tasks using collaborative documents (Google Slides, Google Docs)
• Use audio recordings and screencasts of students solving problems
• Share multiple solution strategies in a shared document for a whole-class discussion; use comments, chat and annotation
• Have students solve a task again using another strategy and connect that strategy to their own
Productive Struggle

Joe’s Ice Cream Task
What is productive struggle?

Take 3 minutes in your breakout groups.

- What does productive struggle look like and sound like?
  - For students?
  - For teachers?

- What does unproductive struggle look like and sound like?

- What can teachers do to:
  - Support productive struggle?
  - Convert unproductive struggle to productive struggle?
Support Productive Struggle in Learning Mathematics

Productive Struggle should:

• Be considered essential to learning mathematics with understanding;

• Develop students’ capacity to persevere in the face of challenge; and

• Help students realize that they are capable of doing well in mathematics with effort.

By struggling with important mathematics we mean the opposite of simply being presented information to be memorized or being asked only to practice what has been demonstrated.

Hiebert & Grouws, 2007, pp. 387-388
Joe’s On the Beach Ice Cream

At Joe’s on the Beach, single-scoop ice cream cones sell for $3.00 and ice cream cakes sell for $25.00. Rosa buys an ice cream cake for her party. She also decides to buy a single-scoop cone for each of her friends.

1. Write a rule that can be used to determine the cost of a cake and any number of cones that Rosa buys.

2. Create a graph that models the problem situation.

Read the mini-dialogues, then in your breakout groups:
- Discuss the nature of each student’s struggle.
- Identify what the teacher does to help students move beyond the impasse they had reached.
- Determine whether or not the teacher supported students’ productive struggle.

Adapted from Institute for Learning (2015). Lesson guides and student workbooks available at ifl.pitt.edu.
Five Teacher Responses to Productive Struggle

• Telling (1)
  supplying students with information that removes the struggle

• Directed guidance (4)
  redirecting students to another strategy consistent with the teacher’s thinking

• Probing guidance (3)
  determining what the student is thinking, encouraging self-reflection, offering ideas based on student thinking

• Affordance (5)
  asking the student to articulate what they have done, encouraging continued effort with limited intervention, allowing students time to work

• Unfocused or vague (2)
  provides a suggestion that is too general to be supportive

Adapted from Warshauer, 2015 and Smith, Steele, & Raith, 2017
Productive Struggle in Virtual and Hybrid Teaching

• Productive struggle fosters engagement
• Encourage Rough Draft Talk (Jansen, 2020) in small-group discussions, explicitly provide opportunities to revise thinking
• Low-threshold, high-ceiling tasks in which students can practice previous skills in the context of new learning are more important than ever
• What’s worth struggling over? Don’t lose sight of the mathematical goal
Effective Mathematics Teaching Practices

Establish math goals to focus learning

Implement tasks that promote reasoning and problem solving

Build procedural fluency from conceptual understanding

Facilitate meaningful mathematical discourse

Pose purposeful questions

Use and connect mathematical representations

Elicit and use evidence of student thinking

Support productive struggle in learning mathematics
Next Steps

• How can you integrate opportunities for productive struggle in your classroom through the tasks you choose and goals you set?

• How will you promote meaningful discourse through productive struggle?

• How will you share with your students and colleagues the importance of meaningful mathematics discourse in learning mathematics?
Thank you!

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